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METHAM SODIUM APPLICATION VIA DRIP IRRIGATION SYSTEMS[1]

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Changes in Florida crop production systems, particularly with respect to irrigation and multiple cropping are mandating reevaluation of nematode management strategies. In Florida, vegetable crops are often produced on raised beds covered by polyethylene mulch. Broad-spectrum soil fumigants, primarily methyl bromide and chloropicrin (MBC), are then often used beneath the polyethylene mulch as a preplant soil borne disease control treatment (6). Water has been traditionally supplied via seep irrigation, but due to declining water levels and increased urban demand, vegetable growers are being forced by water management districts to adopt more water use efficient irrigation practices such as drip irrigation. Increased production costs associated with drip irrigation systems have motivated growers to consider multiple cropping systems in an attempt to amortize these increased irrigation costs over a number of crops.

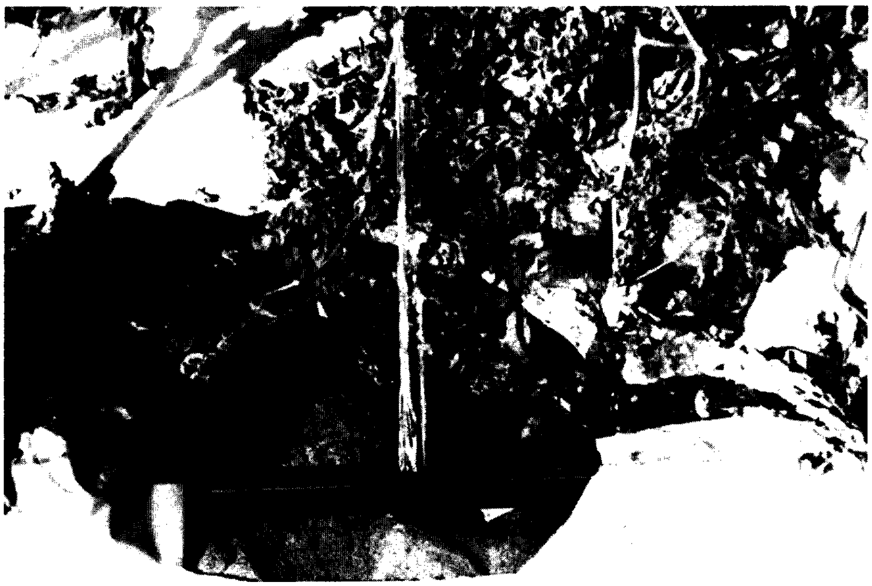

Fig. 1. A ruptured irrigation tube, as pictured here, prevents uniform application of metham sodium.

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Nematode problems result from changing from single to multiple cropping systems. This occurs primarily because soilborne disease control is seldom complete following preplant fumigation with MBC (6). Nematode populations often increase during late season causing little or no damage to the primary fumigated crop, but often cause extensive damage to subsequent crops. Delays in crop destruction following harvest also contribute to greater nematode population increase by allowing additional cycles of pest reproduction. The research challenge for this changing production system involves protection and enhancement of vegetable crop yields following the initial fall fumigated primary crop. This report summarizes recent research findings evaluating the chemigational use of metham sodium for nematode control and crop yield enhancement in Florida drip irrigated, multiple-cropping systems.

Metham sodium (MS) is an infinitely water soluble preplant soil fumigant. When combined with water, MS rapidly decomposes into its bioactive chemical, methylisothiocyanate (MIT) (4,11). MIT is highly volatile and is found in all three phases of the soil-water-air system (3). Once in the soil, the liquid phase of MIT volatilizes into the gaseous form and moves through open air spaces to contact and kill soil borne pests. Unlike other fumigant nematicides, vapor diffusion of MIT through soil is relatively slow (12) due to its high affinity for the water phase (3,11). Because of the slow diffusion of MIT as a gas and high affinity for the water phase, continuous delivery in irrigation water following premixing has generally resulted in more uniform soil distribution and enhanced nematode control and crop yield compared to conventional chisel injection methods (10).

The half-life of MIT in soil is 8-14 days, being highly dependent upon environmental conditions, primarily soil temperature and moisture (1,3,4). If soil conditions are both hot and dry, dissipation of MIT from soil may proceed so rapidly that a nematicidal concentration of MIT will not accumulate (13). Surface water seals have effectively restricted MS loss from soil when mulch is not used (5,2). Conversely, if soils are cool and wet, formation of MIT may proceed too slowly for pesticidal concentrations to be reached (13). At low temperatures, the MIT remains in the soil for an extended period, thus delaying planting or possibly causing phytotoxicity to a newly planted crop (1). Field observations also suggest that rainfall or irrigation which saturates the soil after treatment tends to retain residues for longer periods, particularly in deeper soil layers. In practical terms, soil temperatures from 15 C (60 F) to 32 C (90 F) at a 7.5 cm (3 in) soil depth are suitable for fumigation (2). For chisel injection, soil moisture should be 50-80% of field capacity (3). Optimal soil moisture conditions prior to chemigation injection have not been determined.

NEMATODE CONTROL

Factors which affect nematode control via chemigational delivery of MS have been reasonably well documented. For chemigation, efficacy is largely dependent upon environmental conditions, drip irrigation system design, MS concentration, duration of activity and nematode exposure, and final soil distribution of MIT. Studies in Israel suggest that the minimum effective concentration of MIT in soil solution for nematode control is 50 ppm for at least one week (3).

When a drip irrigation tube is used for delivery, MS is premixed (diluted) with water and continuously delivered in slow drips at discrete locations, dependent on emitter spacings, along the length of the irrigation tubing. Under favorable conditions, continuous application of MS at a constant concentration in irrigation water should result in a soil solution containing the bioactive agent MIT (3). MS must reach the necessary depth in the critical concentration quickly enough to be effective before the MIT breaks down (3,4). Adding MS in one large pulse or in several smaller pulses will lead to areas of high and low MIT concentrations, with the possibility of areas having too low an MIT concentration, especially in the top few cm of the soil (4).

If MS is added through the irrigation system, it is desirable to distribute MIT to the necessary depth with the least amount of water (4). The length of the injection period will depend on soil type, initial soil moisture conditions, and water holding capacity within the volume of the desired wetted zone. For example, longer irrigation times will be required for soils with greater water holding capacity to compensate for reduced water penetration. California studies suggest that water applications allowing MS to penetrate 45-60 cm (18-24 in) is critical for effective nematode control (10).

Burying the irrigation tube can also influence treatment efficacy (7,8). For example, a single injection of MS into the drip irrigation system buried 10 cm (4 in) off bed center and 5 cm (2 in) deep under the plastic mulch has increased tomato yields 45% over the untreated control and 33% over the conventional method of chisel injection. In similar field trials, application of MS into irrigation tubes buried 5 cm (2 in) gave excellent control of root-knot nematode and of purple nutsedge. In this same experiment tomato yields were increased 23% over the untreated controls when the tube was buried to a depth of 5 cm (2 in) at an application rate of 189 liters (50 gal) per acre, but only 5% when the tube was positioned on the bed surface under new plastic mulch. In most studies, increasing the rate of application to the broadcast equivalent of 378 liters (100 gal) per acre has generally improved both nematode control and crop production, particularly with respect to an increase in fruit size (7,8,9,10).

Increasing the number of drip emission points has also improved MS effectiveness. Drip emitter spacings of 20 cm (8 in) and two drip lines per bed enhanced nematode control and crop response more than did a single drip line per bed with drip emitter spacings of 60 cm (24 in). With the single line and drip emitter spacings of 60 cm (24 in) the treated wetted zones were uniform, circular, nonoverlapping areas no greater than 15 cm (6 in) in radius for individual emitters. Closer spaced emitters generally provide greater uniformity of moisture and MIT distribution in soil. With wider emitter spacing, MS may not reach the planting site (frequently midway between emitters) or move uniformly enough within the root zone to be effective. Studies in California and field observations in Florida show that MS treatments were highly effective against root-knot nematode on tomato only when at least 50% of the bed width was treated (10).

The importance of frequent soil dispersion in soil has also been observed in recent studies in Florida involving use of MS for crop destruction after final plant harvest. These studies indicate that plant proximity to drip tube emitters is very important in terms of defining plant phytotoxic concentrations in soil. In two separate experiments, it was observed that MS application rates as low as 38-57 liters (10-15 gal) per broadcast acre could be effectively used for both tomato and pepper crop destruction purposes if plants were within 5 cm (2 in) of individual drip emitters. Identical studies with plants placed 15-20 cm (6-8 in) from the drip line, required 75-114 liters (20-30 gal) per acre to achieve the same plant mortality. Presumably, a two-fold increase in application rate was needed to compensate for the additional distance required to contact the plant root zone.

Another important consideration with regard to MS chemigation involves the integrity of the plastic mulch and drip irrigation tube. In all multiple cropping systems, holes in the plastic mulch are created during the planting process of the primary crop. Mulches which are damaged or torn excessively may retain considerably less MIT in soil for sufficient time to permit pest control (5). Similarly, drip tubing which is clogged or damaged and discharging water excessively at various points in the field will also prevent uniform MS application (Fig 1). Field observations have indicated that under constant pressure, small pin size holes in the drip irrigation tube can result in discharge rates 2 to 9 times greater than normal rates of discharge for individual emitters. As the frequency of these points of excessive discharge increase, the overall field application rate decreases, contributing significantly to observed failures or inconsistance in nematode control.

Maintaining soil moisture between the first and second crop planting is also of upmost importance. In fields where soil moisture conditions cannot be easily and uniformly reestablished, chemical dispersal can be seriously compromised during a preplant MS treatment for a subsequent crop. In fields where water is to be discontinued between crops, chemigation with MS should occur soon after final harvest before soil dries excessively, severely restricting chemical dispersal in soil.

SUMMARY

The decision whether to chemigationally use metham sodium should be based on need. Examination of plant root systems following harvest of the primary crop will provide valuable information regarding incidence, distribution, and severity of potential nematode problems within the field. Once this has been determined, strategies which maximize the lateral dispersal of MS will ultimately translate into higher yields because of the increased rooting volume of nematode free soil. Poor results are obtained with metham sodium if drip tubes are clogged or extensively damaged since uniform field application cannot be achieved. Given the sandy nature of Florida soils, narrower bed widths, drip tubes with closer drip emitter spacing, and planting practices which place plants closer to the drip tube may need to be adopted.

LITERATURE CITED:

1. **Ashley, M. G., B. L. Leigh,** and **L. S. Lloyd.** 1963. The action of metham-sodium in soil. II. - Factors affecting the removal of methyl isothiocyanate residues. J. Sci. Fd. Agric. 14:153-161.
2. **Burgis, D. S.** and **A. J. Overman.** 1959. Vapam and VPM soil fumigant must be applied properly to be effective. Proc. Fla. State Horticul. Soc. 72:112-114.
3. **Gerstl, Z., U. Mingelgrin,** and **B. Yaron.** 1977. Behavior of Vapam and methylisothiocyanate in soils. Soil Sci. Soc. Am. J. 41:545-548.
4. _____, **U. Mingelgrin, J. Krikun,** and **B. Yaron.** 1977. Behavior and effectiveness of Vapam applied to soil in irrigation water. Proc. Israel-France symposium 1975. Special Publication no. 82. pp. 42-50.
5. **Munnecke, D. A.** and **S. D. Van Gundy.** 1979. Movement of fumigants in soil, dosage responses, and differential effects. Ann. Rev. Phytopathol. 17:405-429.
6. **Noling, J. W.** 1987. Multiple pest problems and control on tomato. Fla. Dept. Agric. & Consumer Serv., Div. Plant Ind., Nema. Circ. 139.
7. **Overman, A.J.** 1978. Crop response to SMDC applied through a drip irrigation system. Proc. International Agric. Plastics Congress. 1128-136.
8. _____. 1982. Soil fumigation via drip irrigation under full-bed mulch culture for row crops. Proc. Soil and Crop Sci. Soc. Fla. 41:153-155.
9. _____, and **J. F. Price.** 1983. Application of pesticides via drip irrigation to control nematodes and foliar arthropods. Proc. Soil and Crop Sci. Soc. Fla. 42:92-97.
10. **Roberts, P. A., A. C. Magyarosy, W. C. Matthews,** and **D. M. May.** 1987. Effects of metham sodium applied by drip irrigation on soil populations of root-knot nematodes, *Pythium ultimum* and *Fusarium* sp., and their effects on carrot and tomato roots. Plant Disease 72:213-217.
11. **Smelt, J. H.,** and **M. Leistra.** 1974. Conversion of metham-sodium to methyl isothiocyanate and basic data on the behavior of methyl isothiocyanate in soil. Pesticide Sci. 5:401-407.
12. **Smelt, J. H., M. Leistra, M. C. Sprong,** and **H. M. Nollen.** 1974. Soil fumigation with dichloropropene and metham-sodium: Effect of soil cultivations on dose pattern. Pesticide Science 5:419-428.
13. **Turner, N. J.** and **M. E. Corden.** 1963. Decomposition of sodium N-methyldithiocarbamate in soil. Phytopathology 53:1388-1394.